

**CLAIMS****What is Claimed is:**

1. An implantable cardiac stimulation device comprising:
  - 5 a first sensor that is capable of sensing intrinsic cardiac activity and generating corresponding signals; circuitry that is connected to the sensor to receive signals from the sensor, wherein the circuitry is operative to process the signals to determine an intrinsic heart rate;
  - 10 a second sensor that is capable of sensing a physiologic parameter; circuitry that is connected to the second sensor and that is operative to determine a potential sleep apnea condition based on the sensed physiologic parameter;
  - 15 one or more pulse generators that are capable of generating cardiac pacing pulses to be delivered to the patient; and a control circuit that is responsive to detection of the potential sleep apnea condition to control the one or more pulse generators to pace at an overdrive pacing rate based on the intrinsic heart rate.
  - 20
2. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic that includes a logic capable of detecting a sleep condition, and a logic capable of controlling the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena to overdrive the intrinsic cardiac electrical phenomena to prevent sleep apnea.
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3. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic that detects a sleep apnea condition and controls the one or more pulse
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generators with a timing based on the sensed intrinsic cardiac electrical phenomena and is capable of terminating the detected sleep apnea condition.

5        4. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic including a logic for detecting a sleep condition based on the physiological parameter, and a logic capable of controlling the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena to overdrive the intrinsic cardiac electrical phenomena to prevent sleep apnea.

10      5. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic that detects a sleep apnea condition based on the sensed physiological parameter and controls the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena that is capable of terminating the detected sleep apnea condition.

15      6. An implantable cardiac stimulation device according to Claim 6 wherein the abnormal breathing pattern is indicative of Cheyne-Stokes respiration.

20      7. An implantable cardiac stimulation device according to Claim 1 further comprising:

25            a sensor implantable into a chamber of the heart that is capable of sensing intrinsic electrical phenomena; and  
                a pulse generator of the one or more pulse generators that is capable of generating pacing pulses based on timing of the sensed intrinsic electrical phenomena to dynamically overdrive the intrinsic electrical phenomena, the generated

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cardiac pacing pulses being capable of preventing sleep apnea.

8. An implantable cardiac stimulation device according to Claim 1  
5 wherein the control circuit comprises an executable control logic that is capable of distinguishing between a rest or sleeping condition and a waking condition of a patient based on the physiological parameter, confirming a sleep apnea condition based on the physiological parameter, and generating pacing pulses based on timing of the sensed intrinsic 10 cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical phenomena, the generated cardiac pacing pulses being capable of preventing sleep apnea.

9. An implantable cardiac stimulation device according to Claim 1  
15 further comprising:  
an impedance sensor that is capable of sensing one or more respiration parameters; and  
wherein the control circuit is coupled to the one or more pulse generators and to the impedance sensor, the control circuit comprising an executable control logic that is capable of 20 distinguishing between a sleeping condition and a waking condition of a patient based on the one or more respiration parameters, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical 25 phenomena, the generated cardiac pacing pulses being capable of preventing sleep apnea.

10. An implantable cardiac stimulation device according to Claim 1  
30 further comprising:  
an oxygen sensor that is capable of measuring blood oxygen concentration; and

wherein the control circuit is coupled to the one or more pulse generators and to the impedance sensor, the control circuit comprising an executable control logic that is capable of detecting a sleep apnea condition of a patient based on a blood oxygen concentration indicative that blood oxygen level is depressed during sleep, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical phenomena, the generated cardiac pacing pulses being capable of terminating sleep apnea.

11. An implantable cardiac stimulation device according to Claim 1 further comprising:

a carbon dioxide sensor that is capable of measuring blood carbon dioxide concentration; and  
wherein the control circuit is coupled to the one or more pulse generators and to the impedance sensor, the control circuit comprising an executable control logic that is capable of detecting a sleep apnea condition of a patient based on a blood carbon dioxide concentration indicative that blood oxygen level is depressed during sleep, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical phenomena, the generated cardiac pacing pulses being capable of terminating sleep apnea.

12. An implantable cardiac stimulation device comprising:

a sensor that is capable of sensing intrinsic cardiac electrical phenomena;

a heart rate determination device that is connected to the sensor and is operative to determine an intrinsic heart rate based on the sensed intrinsic cardiac electrical phenomena; circuitry that is capable of generating cardiac pacing pulses at an overdrive pacing rate based on the intrinsic heart rate; and a sleep apnea determination device that is operative to determine when a potential sleep apnea condition exists, and that is responsive to the potential sleep apnea condition to control the circuitry to generate pacing pulses at the overdrive 5  
10  
pacing rate.

13. An implantable cardiac stimulation device according to Claim 12 wherein the sleep apnea determination device comprises a controller that comprises an executable control logic that includes a logic capable of detecting a sleep condition, and a logic capable of controlling one or more pulse generators with a timing based on the sensed intrinsic cardiac 15  
electrical phenomena to overdrive the intrinsic cardiac electrical phenomena.

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14. An implantable cardiac stimulation device according to Claim 12 further comprising:  
a physiological sensor that is capable of sensing a physiological parameter; and  
wherein the sleep apnea determination device comprises a 25  
controller coupled to the sensor, the controller comprising an executable control logic that detects a sleep apnea condition based on the sensed physiological parameter and controls one or more pulse generators with an overdrive pacing rate based on the sensed intrinsic cardiac electrical phenomena.

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15. An implantable cardiac stimulation device according to Claim 12 further comprising:

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- a physiological sensor that is capable of detecting an abnormal breathing pattern; and  
wherein the sleep apnea determination device comprises a controller coupled to the physiologic sensor, the controller comprising an executable control logic that detects the abnormal breathing pattern and controls one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena.
- 10 16. An implantable cardiac stimulation device according to Claim 15 wherein the abnormal breathing pattern is indicative of Cheyne-Stokes respiration.
- 15 17. An implantable cardiac stimulation device according to Claim 12 further comprising:  
an impedance sensor that is capable of sensing one or more respiration parameters; and  
wherein the sleep apnea determination device comprises a controller coupled to the impedance sensor, the controller comprising an executable control logic that is capable of detecting a sleep apnea condition of a patient based on the one or more respiration parameters, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to generate overdrive pacing pulses.
- 20 25 18. An implantable cardiac stimulation device according to Claim 12 further comprising:  
an oxygen sensor that is capable of measuring blood oxygen concentration; and  
30 wherein the sleep apnea determination device comprises a controller coupled to the impedance sensor, the controller comprising an executable control logic that is capable of

detecting a sleep apnea condition of a patient based on a blood oxygen concentration indicative that blood oxygen level is depressed during sleep, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical phenomena, the generated cardiac pacing pulses being capable of terminating sleep apnea.

19. A method of operating an implantable cardiac stimulation device comprising:
- monitoring cardiac activity;
- determining an intrinsic heart rate based on the monitored activity;
- monitoring a physiologic parameter for a potential sleep apnea condition; and
- generating overdrive pacing pulses at an overdrive pacing rate in response to determining a potential sleep apnea condition, wherein the overdrive pacing rate is based on the intrinsic heart rate.
20. A method according to Claim 19 further comprising:
- detecting a sleep condition; and
- generating the overdrive pacing pulses upon detecting the sleep condition.
21. A method according to Claim 19 further comprising:
- detecting a sleep apnea condition; and
- generating the overdrive pacing pulses upon detecting the sleep apnea condition.
22. A method according to Claim 19 further comprising:
- detecting Cheyne-Stokes respiration; and

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generating the overdrive pacing pulses upon detecting the Cheyne-Stokes respiration.

23. A method according to Claim 19 further comprising:  
5       sensing a physiological parameter;  
         distinguishing between a sleeping condition and a waking condition  
         of a patient based on the sensed physiological parameter;  
         generating cardiac pacing pulses based on timing of the sensed  
         intrinsic cardiac electrical phenomena; and  
10      dynamically overdriving the heart.
24. An implantable cardiac stimulation device comprising:  
means for determining an intrinsic heart rate;  
means for detecting a potential sleep apnea condition; and  
15      means for overdrive pacing the heart at a rate based on the  
         intrinsic heart rate in response to detection of a potential  
         sleep apnea condition.
25. An implantable cardiac stimulation device according to Claim  
20      24 wherein the means for detecting a potential sleep apnea condition  
         comprises means for detecting a sleep condition.
26. An implantable cardiac stimulation device according to Claim  
24 wherein the means for detecting a potential sleep apnea condition  
25      comprises means for detecting a sleep apnea condition.

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